CLAIMS

1. An overload clutch assembly for a power tool having a spindle for rotatingly driving a working member of the tool and a spindle rotary drive train for rotatingly driving the spindle, the assembly comprising:

an overload clutch having a first mode in which rotary drive is transmitted to the spindle when a torque below a first predetermined level is applied to the clutch, and transmission of rotary drive to the spindle is cut when a torque above said first predetermined level is applied to the clutch, and at least one second mode in which rotary drive is transmitted to the spindle when a torque below a respective second predetermined level, lower than said first predetermined torque, is applied to the clutch, and transmission of rotary drive to the spindle is cut when a torque above said second predetermined level is applied to the clutch; and

at least one actuator device for switching said overload clutch between said first mode and at least one said second mode.

2. An assembly according to claim 1, wherein the overload clutch comprises at least one driving gear adapted to be driven by a rotary drive train of the tool, at least one first driven gear for transmitting rotary drive to the spindle, a first coupling device for coupling at least one said driving gear and at least one said first driven gear in said first mode when a torque below said first predetermined level is applied to the clutch and enabling decoupling of said driving gear and first driven gear when a torque above the first predetermined level is applied to the clutch, at least one respective second driven gear for transmitting rotary drive to the spindle, and at least one respective second coupling device for coupling at least one said driving gear and at least one said second driven gear when a torque below the corresponding said second predetermined level is applied to the clutch in at least one said second mode, and enabling decoupling of said driving gear and second driven gear when a torque above the second predetermined level is applied to the clutch.

3. An assembly according to claim 2, wherein at least one said coupling device couples at least one driving gear and at least one corresponding driven gear by means of a respective set of locking elements acting between at least one said driving gear and at least one corresponding said driven gear.

4. An assembly according to claim 3, wherein a plurality of said locking elements comprise ball bearings.

5. An assembly according to claim 3 or 4, wherein a plurality of said locking elements comprise rollers.

6. An assembly according to any one of claims 3 to 5, wherein the actuator device is adapted to fix the rotational position of at least one said second driven gear relative to at least one said first driven gear in said first mode.

7. An assembly according to claim 6, wherein at least one said first driven gear and at least one said second driven gear are mounted to a common shaft, and at least one said second driven gear is non-rotatably mounted to said shaft in the first mode thereof and is rotatable relative to said shaft in the second mode thereof.

8. An assembly according to any one of the preceding claims, further comprising at least one detector device for detecting blocking of a working member of the tool, wherein at least one said actuator device is adapted to switch said overload clutch to a said second mode thereof in response to detection of blocking of said working member.

9. An assembly according to any one of the preceding claims, wherein at least one said actuator device is adapted to switch the overload clutch to a said second mode thereof when the tool is switched on.

10. An assembly according to any one of the preceding claims, further comprising at least one biasing device for urging the overload clutch to a said second mode thereof.

11. An overload clutch assembly for a power tool having a spindle for rotatingly driving a working member of the tool and a spindle rotary drive train for rotatingly driving the spindle, the assembly substantially as hereinbefore described with reference to the accompanying drawings.

12. A switching assembly for switching an overload clutch assembly of a power tool between a first mode thereof and at least one second mode thereof, the assembly comprising:

an actuator member movable between a first position corresponding to a first mode, and at least one second position, corresponding to a respective second mode of the clutch assembly;

at least one connector member for actuating at least one actuator device of the clutch assembly in response to actuation of said actuator member; and

a latching device for releasably retaining said actuator member in at least one said second position.

13. An assembly according to claim 12, further comprising at least one biasing device for urging the actuator device of the clutch assembly to at least one said second mode thereof.

14. An assembly according to claim 13, wherein at least one said biasing device comprises a flexible lever.

15. An assembly according to any one of claims 12 to 14, wherein at least one said connector member comprises a cable.

16. An assembly according to any one of claims 12 to 15, wherein said latching device comprises at least one releasable abutment for abutting a resilient member provided on said actuator member.

17. An assembly according to any one of claims 12 to 16, further comprising a release device for releasing said latching device.

18. An assembly according to claim 17, wherein said release device comprises an electromagnet for displacing said abutment.

19. An assembly according to claim 17 or 18, wherein said release device is adapted to be actuated on switching on of the tool.

20. A switching assembly for switching an overload clutch assembly of a power tool between a first mode thereof and at least one second mode thereof, the assembly substantially as hereinbefore described with reference to the accompanying drawings.

21. A power tool comprising a spindle for rotatingly driving an output member of the tool;

a spindle rotary drive train for rotatingly driving the spindle; and

an overload clutch assembly according to any one of claims 1 to 11.

22. A tool according to claim 21, comprising a switching assembly according to any one of claims 12 to 20.

23. A hand held power tool, comprising:

a spindle (40) for rotatingly driving a tool or bit (68);

a spindle rotary drive train (14, 5, 10) for rotatingly driving the spindle (40);

an overload clutch (14) in the spindle rotary drive train for transmitting rotary drive to the spindle below a predetermined torque and for cutting transmission of rotary drive above the predetermined torque; and

an arrangement for detecting blocking events (16, 17);

characterised in that the overload clutch is arranged to cut off rotary drive to the spindle when a blocking event is detected.

24. A tool according to claim 23 which is a rotary hammer and additionally comprises a hammering mechanism (38, 58, 64) for generating repeated impacts on a tool or bit (68) mounted at a forward end of the spindle.

25. A tool according to claim 23 or claim 24 wherein the predetermined torque is reduced when a blocking event is detected to thereby cut off rotary drive to the spindle.

26. A tool according to claim 25 wherein the predetermined torque is reduced substantially to zero when a blocking event is detected.

27. A tool according to any one of claims 23 to 26 wherein the arrangement for detecting blocking events generates an electrical output signal when a blocking event is detected and the overload clutch (14) includes an electro-mechanical interface (18, 19, 21) which is responsive to the output signal to cut off rotary drive to the spindle.

28. A tool according to claim 27 wherein the electro-mechanical interface comprises an electromagnet (19).

29. A tool according to any one of claims 23 to 28, wherein the arrangement for detecting blocking events comprises a sensor (16) for sensing an operational condition of the tool and an electronic evaluation unit (17) for analysing the signals from the sensor and for generating an electrical output signal when a blocking event is detected.

30. A tool according to any one of claims 23 to 26 wherein the arrangement for detecting blocking events is a mechanical arrangement (72, 74, 82).

31. A tool according to claim 30 wherein the mechanical arrangement includes an inertial mass (72) pivotally mounted within the housing (4) of the tool.

32. A tool according to claim30 or 31 wherein the arrangement for detecting blocking events comprises:

an inertial mass (72) pivotally mounted within the tool housing (4) comprising a latch (86) for engaging an actuator (21) of the overload clutch; and

a spring (92) provided for urging the actuator of the clutch into a cut off position; arranged such that when a blocking event occurs, the inertial mass pivots in the housing to disengage the latch (86) from the actuator and the spring (92) urges the actuator into the cut off position in which the actuator causes the rotary drive to the spindle to be cut off.

33. A tool according to any one of claims 23 to 32 in which the overload clutch (14) comprises a driven gear (13) and a driving gear (12) and a coupling element (21, 26, 100, 110, 112, 114, 107, 130) for coupling the driven gear and driving gear below the predetermined torque and for enabling de-coupling the driven gear and the driving

gear above the predetermined torque, wherein the arrangement for detecting blocking events (18, 19, 21, 72, 74, 82) acts on the coupling element (21, 26, 100, 110, 112, 114, 107, 130) to cut off rotary drive to the spindle when a blocking event is detected.

34. A tool according to claim 33 wherein the coupling element (21, 26, 100, 110, 112, 114, 107, 130) couples the driven gear and the driving gear via a set of locking elements (25) mounted on one of the driven gear and the driving gear and engageable with the other of the driven gear and the driving gear in order to transmit rotary drive therebetween.

35. A tool according to claim 33 or claim 34 wherein the arrangement for detecting blocking events (18, 19, 21, 72, 74, 82) acts to move the coupling element (21, 26, 10, 100, 110, 112, 114, 107, 130) with respect to the driven and driving gears.

36. A tool according to any one of claims 33 to 35 wherein the coupling element is a resilient element (26, 100, 100, 110, 112, 114).

37. A tool according to any one of claims 23, 24 or 26to 32 in which the overload clutch (14) comprises a driven gear (13) and a driving gear (12) and a coupling element (105, 107) for coupling the driven gear and driving gear below the predetermined torque and for enabling de-coupling the driven gear and the driving gear above the predetermined torque and a drive coupling (21, 113, 115) for coupling the driven gear to the output of the overload clutch, wherein the arrangement for detecting blocking events (18, 19, 21 72, 74, 82) acts on the drive coupling (21, 113, 115) to cut off the transmission of rotary drive.

38. A tool according to claim 37 wherein there are two driven gears (13c, 13d) and one of the driven gears can be coupled to the output (5) of the clutch via the drive coupling (21, 113, 115) so that overload clutch has a first predetermined torque, the other or both of the driven gears can be coupled to the output of the clutch via the drive coupling (21, 113, 115) so that the overload clutch has a second predetermined torque, different from the first or neither of the driven gears can be coupled to the

output of the clutch via the drive coupling (21, 113, 115) so that the transmission of rotary drive by the overload clutch is cut off.

39. A tool according to claim 38 wherein neither of the driven gears is coupled to the output of the clutch via the drive coupling (21, 113, 115) in response to the activation of the arrangement for detecting blocking events (18, 19, 21 72, 74, 82).

40. A tool according to any one of claims 23 to 39wherein the overload clutch (14) has:

a first mode of operation in which the overload clutch transmits rotary drive to the spindle below a first predetermined torque and stops transmission of rotary drive above the first predetermined torque;

a second mode of operation in which the overload clutch transmits rotary drive to the spindle below a second predetermined torque, different from the first predetermined torque and stops transmission of rotary drive above the second predetermined torque; and

a third mode of operation in which the overload clutch cuts off rotary drive to the spindle when a blocking event is detected.

41. A tool according to any one of claims 23 to 40which is a rotary hammer and additionally comprises:

a hammering mechanism (38, 58, 64) for generating repeated impacts on a tool or bit (68) mounted at a forward end of the spindle (40); and a

mode change arrangement (126, 128) for switching the hammer between rotary and non-rotary modes of the hammer;

wherein the overload clutch (14) cuts rotary drive to the spindle in response to the mode change arrangement switching the rotary hammer to a non-rotary mode.

42. A hand held rotary hammer, comprising:

a spindle (40) for rotatingly driving a tool or bit (68);

a hammering mechanism (38, 58, 64) for generating repeated impacts on a tool or bit (68) mounted at a forward end of the spindle;

a spindle rotary drive train (41, 5, 10, 43) for rotatingly driving the spindle (40);

a mode change mechanism (45, 47, 49, 126, 128) for selectively disengaging a clutch (10, 43, 7, 14) of the spindle drive train so as to cut off the rotary drive to the spindle (40); and

an arrangement for detecting blocking events (16, 17);

characterised in that the clutch is arranged to disengage when a blocking event is detected.

43. A rotary hammer according to claim 42 wherein the arrangement for detecting blocking events generates an electrical output signal when a blocking event is detected and the clutch includes an electro-mechanical interface (18, 19, 10, 43) which is responsive to the output signal to disengage the clutch.

44. A rotary hammer according to claim 43 wherein the electro-mechanical interface comprises an electromagnet (19).

45. A rotary hammer according to any one of claims 42 to 44wherein the arrangement for detecting blocking events comprises a sensor (16) for sensing an operational condition of the tool and an electronic evaluation unit (17) for analysing the signals from the sensor and for generating an electrical output signal when a blocking event is detected.

46. A rotary hammer according to claim 42 wherein the arrangement for detecting blocking events is a mechanical arrangement (72, 74, 82).

47. A rotary hammer according to claim 46 wherein the arrangement for detecting blocking events comprises:

an inertial mass (72) pivotally mounted within the tool housing comprising a latch (86) for engaging an actuator (21) of the clutch; and

a spring (92) provided for urging the actuator of the clutch into a cut off position;

arranged such that when a blocking event occurs, the inertial mass pivots in the housing to disengage the latch (86) from the actuator and the spring (92) urges the actuator into the cut off position in which the actuator disengages the clutch.

48. A rotary hammer according to any one of claims 42 to 47 in which the clutch includes a spindle drive gear arrangement (10, 43) axially slideably mounted on the spindle and selectively engageable with a part of the spindle drive train (7) in order to rotatingly drive the spindle wherein the arrangement for detecting blocking events moves the spindle drive gear arrangement axially along the spindle and out of engagement with the part of the spindle drive train when a blocking event is detected.

49. A rotary hammer according to any one of claims 42 to 48 in which the clutch includes a spindle drive gear arrangement (10, 43) axially slideably mounted on the spindle and selectively engageable with a part of the spindle drive train (7) in order to rotatingly drive the spindle wherein the mode change arrangement (45, 47, 49) acts on the spindle drive gear arrangement to move the spindle drive gear arrangement axially along the spindle and out of engagement with the part of the spindle drive train.

50. A rotary hammer according to any one of claims 42 to 49 in which the clutch is an overload clutch (14).

51. A rotary hammer according to claim 50 wherein the overload clutch comprises a driven gear (13) and a driving gear (12) and a coupling element (21, 26, 100, 110, 112, 114, 107, 130) for coupling the driven gear and driving gear below the predetermined torque and for enabling de-coupling the driven gear and the driving gear above the predetermined torque, wherein the arrangement for detecting blocking events acts on the coupling element (21, 26, 100, 110, 112, 114, 107, 130) to reduce the predetermined torque to thereby cut off rotary drive to the spindle when a blocking event is detected.

52. A rotary hammer according to claim 51 wherein the coupling element (21, 26, 100, 110, 112, 114, 107, 130) couples the driven gear and the driving gear via a set of locking elements (25) mounted on one of the driven gear and the driving gear and engageable with the other of the driven gear and the driving gear in order to transmit rotary drive therebetween.

53. A rotary hammer according to claim 51 or claim 52 wherein the arrangement for detecting blocking events (18, 19, 21, 72, 74, 82) acts to move the coupling element (21, 26, 10, 100, 110, 112, 114, 107, 130) with respect to the driven and driving gears.

54. A rotary hammer according to any one of claims 51 to 53 wherein the coupling element is a resilient element (26, 100, 100, 110, 112, 114).

55. A rotary hammer according to claim 50 in which the overload clutch (14) comprises a driven gear (13) and a driving gear (12) and a coupling element (105, 107) for coupling the driven gear and driving gear below the predetermined torque and for enabling de-coupling the driven gear and the driving gear above the predetermined torque and a drive coupling (21, 113, 115) for coupling the driven gear to the output of the clutch, wherein the arrangement for detecting blocking events (18, 19, 21 72, 74, 82) acts on the drive coupling (21, 113, 115) to stop the transmission of rotary drive.

56. A hand held rotary hammer, comprising:

a spindle (40) for rotatingly driving a tool or bit (68);

a hammering mechanism (38, 58, 64) for generating repeated impacts on a tool or bit (68) mounted at a forward end of the spindle;

a spindle rotary drive train (14, 5, 10) for rotatingly driving the spindle (40);

an overload clutch (14) in the spindle rotary drive train for transmitting rotary drive to the spindle below a predetermined torque and for cutting transmission of rotary drive above the predetermined torque;

a mode change mechanism (126, 128) for selectively cutting off the rotary drive to the spindle (40);

characterised in that the overload clutch (14) includes:

a first mode of operation in which the overload clutch transmits rotary drive to the spindle below a first predetermined torque and stops transmission of rotary drive above the first predetermined torque;

a second mode of operation in which the overload clutch transmits rotary drive to the spindle below a second predetermined torque, different from the first

predetermined torque, and stops transmission of rotary drive above the second predetermined torque; and

a third mode of operation in which the overload clutch cuts off rotary drive to the spindle in response to the mode change mechanism (126, 128).

57. A hammer according to claim 56 in which the overload clutch (14) comprises a driven gear (13) and a driving gear (12) and a coupling element (105, 107) for coupling the driven gear and driving gear below the predetermined torque and for enabling de-coupling the driven gear and the driving gear above the predetermined torque and a drive coupling (21, 113, 115) for coupling the driven gear to the output of the clutch, wherein the mode change arrangement (126, 128) acts on the drive coupling (21, 113, 115) to stop the transmission of rotary drive.

58. A hammer according to claim 57 wherein there are two driven gears (13c, 13d) and one of the driven gears can be coupled to the output of the clutch via the drive coupling (21, 113, 115) so that the overload clutch has a first predetermined torque, the other or both of the driven gears can be coupled to the output of the clutch via the drive coupling (21, 113, 115) so that the overload clutch has a second predetermined torque, different from the first or neither of the driven gears can be coupled to the output of the clutch via the drive coupling (21, 113, 115) so that the transmission of rotary drive is stopped.